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TARGET CONDUCTANCE AND VIDICON RESOLUTION

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In the past Vidicons, intended for use in broadcasting and applied television systems have often been employed as storage devices. Definition of the spread of charge over the surface of the target owing to its cross-sectional, volumetric and surface conductance takes on a considerable role in the analysis of Vidicon resolution.

Considering that, as reference 1 points out, small attention has been paid to the problem under consideration, we shall examine the distortion by the Vidicon target of the charge pattern under the combined effects of conductance of the lateral and longitudinal components of the photosemiconductive layer. We propose that the charge contour is carried to the Vidicon target either by means of electrical recording or by pulse illumination.

If one assumes that the photosemiconductor of the target is homogeneous in thickness and the charge is distributed on the surface of the layer, then the expression of the value for the electrical potential outside layer I and inside layer II of the target (see Fig. 1) may be found from the solution of the Laplace equation.

A change in the charge density on the target surface under the influence of lateral and longitudinal conductance of the photosemiconductor layer, in accordance with reference 2, we estimate on solution of the Laplace equation, supposing that the electroconductance of the layer is not dependant on the electrical field and the current across it, dictated by the charge run-off onto the signal plate is subject to Ohm's law.

The expression we obtained for the charge pattern on the Vidicon target surface attests to the presence of distortion of the initial charge contour brought about by the conflict of the charge pattern to the charge and the influence of conductance across and up and down the photo-semiconductor layer. This expression has been used to calculate the transitory characteristics of the Vidicon target.

By transitory characteristics of the target $h_q(x)$ in relation to the initial charge, we understand the relative charge distribution on the target surface at its initial distribution in two forms, one of which is not charged while the other - the surface charge density at the moment in time $t = 0$ equals q_0 . Both these areas are divided by abrupt boundaries.

The transitory characteristics of the target for the case under review were obtained in the form:

$$h_q(\chi) = 0.5 + 0.63 \epsilon \exp \left(\frac{12.56\tau}{\theta\epsilon} \right) \int_0^{\infty} F_1 F_2 \sin \chi \zeta d\zeta,$$

$$\text{where: } F_1 = \exp \left[-6.3 F_2 \zeta \tau \left(\frac{4}{\theta} + \zeta \right) \right]; \quad (1)$$

$$F_2 = \frac{1 - \exp \zeta}{\zeta^2 [1 - \epsilon - (1 + \epsilon) \exp \zeta]}.$$

In these expressions: $\zeta = 2\xi\delta$; $\chi = \frac{x}{2\delta}$; $\tau = \frac{t}{\rho_1}$; $\theta = \frac{\rho_2}{\rho_1}$

generalized co-ordinates: ξ = spatial frequency; δ = target thickness; ρ_1 and ρ_2 = specific resistance across and along the target layer respectively; ϵ = dielectric penetrability of the layer; t = charge storage time on the target.

Figure 2 shows the transitory characteristics of Vidicon targets, calculated by formula (1) where the following photosemiconductor parameters apply⁽²⁾:

$$\rho_1 = 10^{11} \text{ ohm/cm}; \quad \rho_2 = 10^{12} \text{ ohm/cm}; \quad \delta = 2 \text{ mkm}; \quad \epsilon = 10.$$

Curves 1, 2, 3, 4 and 5 of Figure 2 correspond to initial charge storage times of 6.4×10^{-3} secs; 0.02 sec; 0.04 sec; 0.2 sec; 1.0 sec.

These curves can be considered as dependent on the parameter θ ($\theta_1 = 3$; $\theta_2 = 10$; $\theta_3 = 20$; $\theta_4 = 100$) where $\rho_2 = 10^{12}$ ohm/cm, $\delta = 2$ mkm and the charge storage time $t = 0.02$ sec.

Figure 3 shows curves of the dependence of the erosion zone of the initial charge boundary on storage time for various target layer thickness values corresponding to the permissible scatter δ of standard Vidicons.

Curves 1, 2, 3 and 4 of Figure 4 illustrates the dependence of the erosion zone of the sharp edge of the charge contour on the dielectric penetrability of the Vidicon target photosemiconductor ϵ ($\epsilon_1 = 3$; $\epsilon_2 = 10$; $\epsilon_3 = 30$; $\epsilon_4 = 100$) when $t = 0.02$ secs, $\theta = 10$, $\delta = 2$ mkm.

With the aid of the curves in Figs. 3 and 4 it is easy to establish the dependence of the erosion zone of the sharp edges of the image, if the Vidicon target parameters are known at various initial contour storage times.

Conclusions on Vidicon target resolution capability were made on the basis of an analysis of the transitory characteristics of Fig. 2. In this we examined distortions by the Vidicon target of the image of separate strokes, pairs of strokes and so on, which were checked experimentally on several LI-418 type Vidicons. Experimental study of the reduction in relative significance of potential on the target in the memory process led to the use in the capacity of a test image of a bright strip, which was projected onto the target with the aid of an optical aperture by means of pulse illumination.

Exposure was selected in such a manner that the inertia in target photoconductance change had an inconsiderable effect on the results of the measurements. It was established, however, that experimental and theoretical data, characterizing reduction in LI-418 Vidicon resolution in the charge pattern storage process, practically coincides with the limits of the spread of voltage variations on the signal plate, recommended in the instrument instructions as operating data.

CONCLUSIONS

1. The depth of the charge pattern from the image detail, corresponding to a definition of 600 lines at the height of the raster, when the Vidicon is operating in moving picture projection, with pulse illumination, reduces on account of spread of charge by not more than 6%.

2. Comparison of the results obtained with those in the references indicates that when used for motion picture projection the Vidicon resolution may be increased by optimization and stabilization of its electrical operating regime⁽³⁾.

3. Reduction in modulation depth of the charge pattern from the image details, corresponding to a definition of 600 lines at the height of the raster, in Vidicons with target parameters as examined, does not exceed 20% for storage times up to 0.2 secs and reaches 73% with charge pattern storage times in the order of 1 second.

R E F E R E N C E S

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- (2) GERSHBERG, A.E.: Peredayushchie televizionnye trubki, ispol'zuyushchie vnutrennij fotoeffekt (vidikony), (TV transmission tubes utilizing the internal photoeffect (vidicons). M - L, Energiya (1964).
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F I G U R E S

- Fig. 1: Vidicon target:
1 - Photosemiconductor; 2 - metallic backing (signal plate).
- Fig. 2: Transitory characteristics of a vidicon target at various initial charge storage times.
- Fig. 3: Dependence of the charge contour sharp edge erosion zone on storage time at various layer thicknesses of the target.
- Fig. 4: Transitory characteristics of the target at various values of dielectric penetrability of the layer.

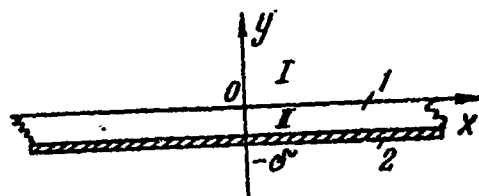


FIG 1

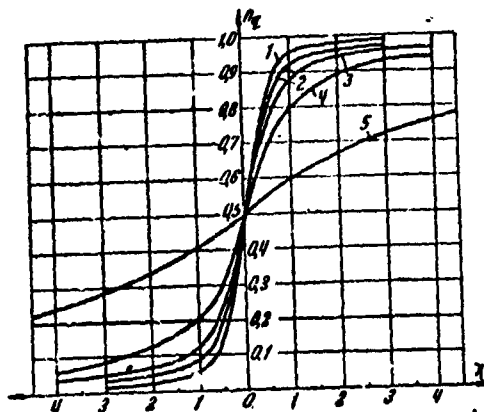


FIG 2

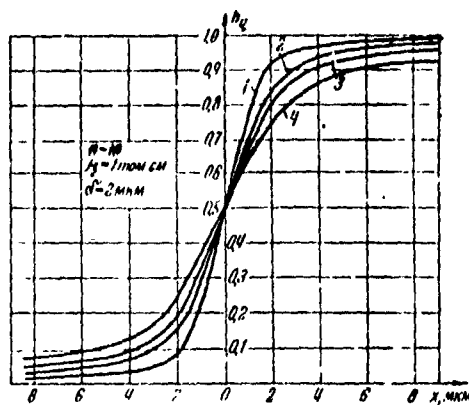


FIG 3

